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WHITEHOUSE, VIRGINIA MICROPROCESSOR STUDY.(U)

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8757 Georgia Avenue
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WHITEHOUSE, VIRGINIA MICROPROCESSOR STUDY.

9 FINAL REPORT,

15 ~~Prepared Under~~
Contract N00014-77-C-0778, for the Earth Sciences Division, Office of Naval Research, 800 North Quincy Street, Arlington, Va.-22217, Mr. John J. Kane (Code 464).

By

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SECTION 1

INTRODUCTION

The Whitehouse Field Site (WHFS) is an HF research facility operated and maintained by ITT Federal Electric Corporation for the Office of Naval Research (ONR). The site was established in 1968 as an experimental site for the study of Ionospheric Phenomenology and evaluation of Over-the-Horizon (OTH) HF Communications and Radar Systems.

Much of the equipment used at the site was designed and maintained by the ITT Electro-Physics Laboratories. Since the closing of ITT-EPL in 1976, field maintenance of the site has been provided by ITT Federal Electric Corporation. With the fast changing technology, the present equipment is becoming obsolete. In several cases, maintenance of the older equipment is impossible.

This report proposes changes, both technical and operational, which will make the site attractive to a variety of experimental and casual users in the HF community.

SECTION 2

WHITEHOUSE FIELD SITE ASSETS

The WHFS has many assets which make it a unique and excellent site for conducting HF propagation experimental research. Specifically, the features of the site are:

- The WHFS is located in a remote section of Virginia. This means that man-made noise and interference with large population centers are minimized.

- The WHFS has 640 acres of land and, if necessary, access to an additional 600 acres. The additional land capability means the North East array could be expanded to approximately 2 miles, which would give the user an antenna aperture of over 9,000 feet. This could provide an equivalent capability to West Coast SRI configuration.

- The WHFS has wideband, high gain, and electrically steerable arrays of

  a) Folded Triangular Monopoles (FTM's)
  b) Horizontal Log-Periodic (HLPA's)
  c) Vertical Log Periodic (VLPA's)
  d) Cross Dipole (X-Pole)

  The antennas are set up with or without aperture taper with sidelobe control, and can be used for transmitting or receiving.

- ATL-75 transmitter arriving shortly

- 2.5 Megawatt transmit capability into south-look, 160°, array

- Chapel Bell/Tango transmit capability into all antennas, except FPS-112 south-look array

- Wideband 14 dB noise figure receivers. The receivers have a sensitivity of .2 microvolts across the operating frequency of the receivers.

- Site is within 25 miles of Byrd International Airport

- Site is close to Interstate 64

The WHFS is the only facility on the East Coast with such diversity and potential. With proper upgrade and planning, the WHFS can again play an active role in the military development of Over-the Horizon Radar Systems.

SECTION 3

BASIC ASSUMPTIONS

The suggestions given later in this report are based on several premises which are stated below.

- Man power is not only the most expensive but most limited resource available at the site and hence its conservation is of critical importance.
- Most users would be transient residents and do not wish to commit their own personnel to such a necessarily isolated site for protracted periods.
- The use of the site would become more attractive if the investments required in money and time to conduct meaningful investigations were to be made minimal for the potential customer.
- Technical changes should be economical in both initial costs and upkeep costs.
- Technical changes should be such that they should be strongly resistant to obsolescence by virtue of ready modification and adaptation to technological progress.
- Proper documentation of all changes as well as "status quo" facilities should be addressed so as to remove the vulnerabilities of personnel changes, etc.
- Site should be easily accessible and the cost to a user should be minimized.

SECTION 4

POSSIBLE WHITEHOUSE OPERATIONS

While difficult to state with a high degree of conviction, reasoned arguments can be presented which will support the likely operational roles stated below. The plan presented, however, is not predicated upon these roles, and would be adaptable with little or no change to a large range of operational scenarios. For the present discussion a group of likely functions and missions to be pursued at the site has been listed. An attempt to list them in the order of decreasing "popularity" has been made. This, however, represents "an estimate of an estimate" and hence should be considered as only the coarsest of estimates. Although the weighting might change, it is nevertheless useful to enumerate the possible missions.

- Routine monitoring of HF signals which originate elsewhere, either cooperatively or noncooperatively, for which normal detector outputs are recorded.
- Special monitoring of signals of a complex nature in which special types of detections and complex recording of outputs are required.
- Atmospheric noise, or propagation beacon monitoring for extended periods; such operations place special requirements on calibration stability, etc.
- Active sounding of propagation path using either stepped-frequency forward-propagated sounds or backscatter sounders, either of which can and usually do require radiation from the site.

- Higher-powered, backscatter sounding for other types of path utilization such as special communications, etc.

- Operation of a high-powered HF radar, either monostatic or bistatic for target acquisition and tracking purposes.

- Other special operations not properly covered in any of the foregoing categories.

SECTION 5

EXISTING COMPUTER CONFIGURATION

The presently-installed computer system, an SEL-85, was designed for real-time signal acquisition and processing, and control of external receivers. Software has been developed for these functions. The configuration includes:

- SEL 85 Central Processing Unit with 32,000, 32 bit, memory
- Teletype terminal
- 6 Million byte disk
- Centronix line printer

The configuration was designed for software support from a separate SEL-85 system, i.e., system generation must be performed on a different machine that has both the 6 million byte disk and at least one magnetic tape drive. This function was previously performed at an ITT facility, but is no longer available from ITT. In fact, no other SEL-85 exists on the East Coast that could provide the support.

In order to upgrade the WHFS computer to where it could be self-supporting, new peripherals are needed. These include a 9-track tape unit and a higher-speed line printer. An estimate of the purchase cost of these two components is $45,000.

Several other problems exist with this computer configuration. In recent years, the machine has not been under a vendor maintenance program. Some 150 modifications are required to bring the mainframe up

to the current engineering change level. An estimate for these modifications is $20,000. In addition, the vendor has announced termination of support for this series of computers, effective 30 September 1978. This support includes software maintenance, spares inventory, user training, and hardware maintenance.

In view of all of the above discussion, it is strongly recommended that no additional funds be expended to support the SEL-85 computer system at Whitehouse.

SECTION 6

FUTURE COMPUTER REQUIREMENTS

In the past, several experimental uses of the WHFS have required real-time signal processing to be performed within a general-purpose computer. In the majority of these cases, serious technical problems have been encountered because of the need for on-site software development, the lack of proper computer-room environmental control, and logistics difficulties in supporting a medium-size computer in a remote geographic location. The costs of performing real-time digital signal processing at the site were accordingly high. Therefore, it is recommended that future experimental users of the site operate in a mode where detailed signal processing and analysis be done off-line at the researcher's home facility, and site processing would consist only of data acquisition and possible equipment control.

It is recommended that the routine site functions could be automated and thereby provide better operational performance. Some of the benefits afforded by automation are:

- More precise timing
- Higher reliability
- More accurate log keeping
- Improved data interfacing with either on or off-line processors

In addition to the implied automation of routine operational functions, a remotely located user should have the options of interrupt, pre-emption, or reprogramming of any automated operation of the site by means of telephone transmission.

6.1 SUGGESTED PROGRAMMABLE OPERATIONS

No effort to be complete has been made here, but an attempt has been made to include the essential operations together with some of the more obvious and desirable options which are not classifiable as essential.

1) Essential Programmable Functions for Operations

- Receiver turn on and turn off
- Receiver frequency selection
- Receiver frequency changes
- Calibration gain runs
- Recorder starts and stops
- Tape runout detection and recorder transfers
- Antenna beam selections
- Logging functions
- Transmitter operations
- Antenna VSWR check for transmitter
- Backscatter receipt verification
- Transmit antenna changes and necessary preliminary checkout of VSWR prior to transmission
- Transfer of detector outputs to telephone lines
- Acceptance of telephonic commands to alter programs
- Power failure alarms to remote supervision via telephone relay
- Monitor the operating environment

2) Desirable But Not Essential Programmable Functions; Operations and Housekeeping

- Monitor and recording of primary power continuity and disruptions
- Progress reporting of programmed operations if and when telephone inquiry made
- Housekeeping functions such as: Antenna VSWR's power outputs of transmitters, atmospheric noise levels, power line voltage, room temperatures, thunderstorm or other weather effects, etc.

6.2 COMPUTER DESIGN

The general-purpose computer was designed to solve a large class of problems. Limiting design compromises are frequently required when the flexibility of the general-purpose computer is not needed for specialized processing applications. For certain applications, recent technological developments have enabled the microprocessor to overtake and surpass the minicomputer. The real beauty of the microprocessor is that the user can design a system architecture that ranges from process control to a sophisticated computational tool. With microprocessors, the user can configure the system to fit his unique situation.

The microcomputer represents a great opportunity to develop systems more economically, not only because of decreasing hardware costs, but rather because the availability of low-cost high computational capability permits the application of methodology that could not previously be economically justified.

6.2.1 Microprocessor Control

Under the suggested approach, the automation of some of the WHFS functions will be controlled by a microcomputer. With the rapidly decreasing hardware costs, a powerful computer system is within the reach of many individuals. A possible microcomputer system for use at the WHFS will consist of:

- Microprocessor mainframe
- 16000 words of memory
- 1000 words read only memory
- Floppy disk
- Cassette tape recorder
- Video terminal
- Hard copy device

Figure 6-1 shows a block diagram for a microcomputer system. The system was configured to permit efficient software development and system operation. The floppy disk would be used for the storage of user programs and could be added to the system when the situation dictates. The reader will notice that one cassette tape recorder operates in a read only mode. This recorder contains the system software.

6.2.2 System Software

A computer with all its peripheral devices is useless without some system software to provide the necessary communication. When a microcomputer is purchased, some system software is generally included. Since the microcomputers are being offered to the general public and because the system software has been in use for several years, little if any trouble should be experienced in this area. At a minimum, the system software should include:

- **Linker** — Links the subprograms into a load module.
- **Loader** — Loads software into the memory for execution.
- **High-Level Language** — Such as BASIC or APL. Permits the user to use English type statements to perform operations.
- **Computer-Level Compiler** — Compiles programs written by the user in interpretive computer language. As an example, coding of I/O drivers is done at this level.
- **Text Editor** — Creates source level code.
- **Debug** — Checks the operation of the microcomputer and its support devices.

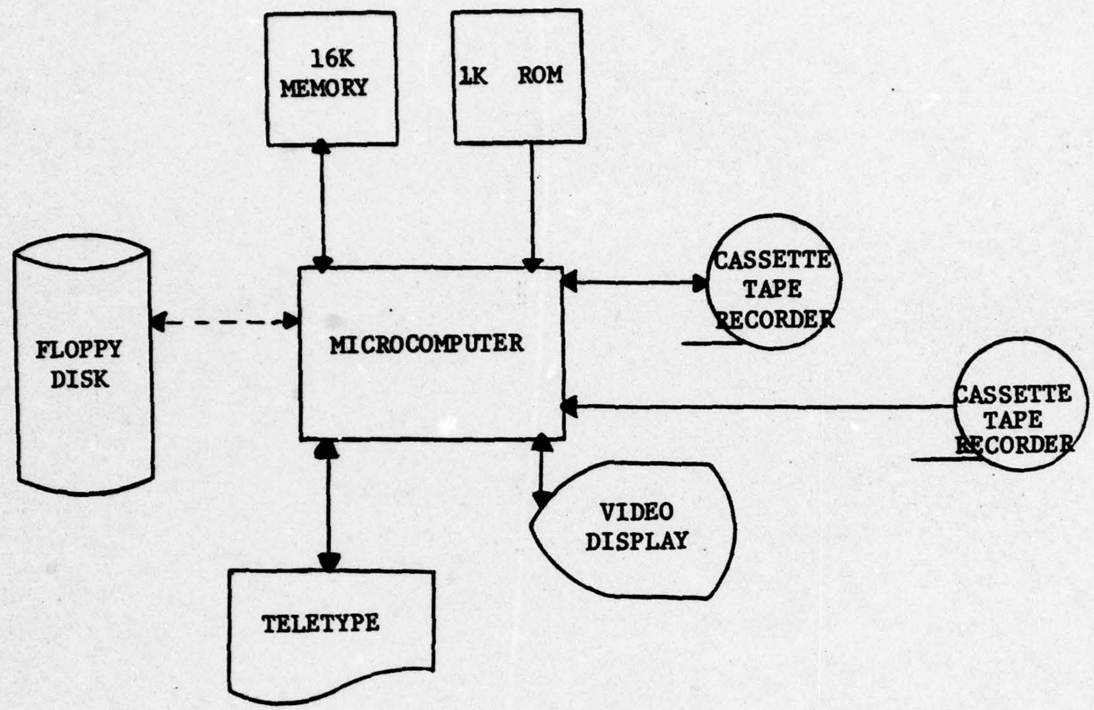

FIGURE 6-1 <u>RECOMMENDED MICROCOMPUTER CONFIGURATION</u>

6.2.3 Hardware Maintenance

The responsibility for isolating the hardware problem will be with the site personnel. These individuals are very highly trained and should have no trouble narrowing the problem to a particular circuit board. Once this is accomplished, the board can be replaced, and the defective board shipped to the vendor to be repaired. Since the cost of a complete set of spare boards is minimal, it is suggested that these items be stocked at the site.

6.2.4 Cost of Microcomputer System

The cost of the microcomputer system, shown in Figure 6-1, depends upon many factors.

- Vendor
- Quantity
- Buyer OEM
- Computer System Purchased

The prices given here were derived from technical journals and are intended only to give a representative figure, not the actual price.

Microcomputer (Including Software) (Memory and ROM)	$1,700
Cassette Tape Recorder (2)	150
Floppy Disk	1,000
Video Terminal	400
Teletype (Use One With SEL-85)	NC
TOTAL COST	$3,250

The significant cost of the microcomputer system is the floppy disk, which represents about one-third of the total cost. A little over five years ago this item sold for over $7,500. This alone demonstrates the falling hardware costs. Since the floppy disk would not be initially required, the cost of the initial system could be reduced by deleting this item.

6.2.5 Interface Standards

The modern oscilloscope and the voltmeter are microprocessor controlled and are IEEE 488 Bus compatible. This permits the instruments to make measurements under the control of a master microprocessor. It is recommended that any system setup at Whitehouse conform to the IEEE 488 standards

SECTION 7

REMOTE OPERATIONS

Section 5 detailed many WHFS functions that could be automated. The addition of remote operations would make the site available any time day or night from practically any point from which a phone call can be made. Figure 7-1 shows the block diagram for remote signal monitoring. When the system is not in use, the equipment would be kept in a stand-by status. When a user desired to record data, he would dial the remote operations telephone number. As soon as the telephone connection was made, the equipment status would be changed from stand-by to ready. When the initial system software gains control, all devices would be polled to ensure they are functioning properly.

Any malfunctions would be logged. This operation would be transparent to the user. When the system is ready, the user would be asked to define some general instructions such as:

- Users Name
- Telephone Number
- Tape Editing Instructions
- Shipping Address

When information has been recorded, the user would enter, via the telephone tone pad, the parameters to perform his operation. Figure 7-2 Figure 7-2 details a possible user scenario for monitoring a signal. When all parameters have been entered, the user would hang up. The system would then proceed to execute his instructions. If for some reason the user needed to change a program parameter, he would again dial the remote operations number. After conforming to an interrupt protocol, he would be able to modify the operational parameter(s). Figure 7-3 shows a possible

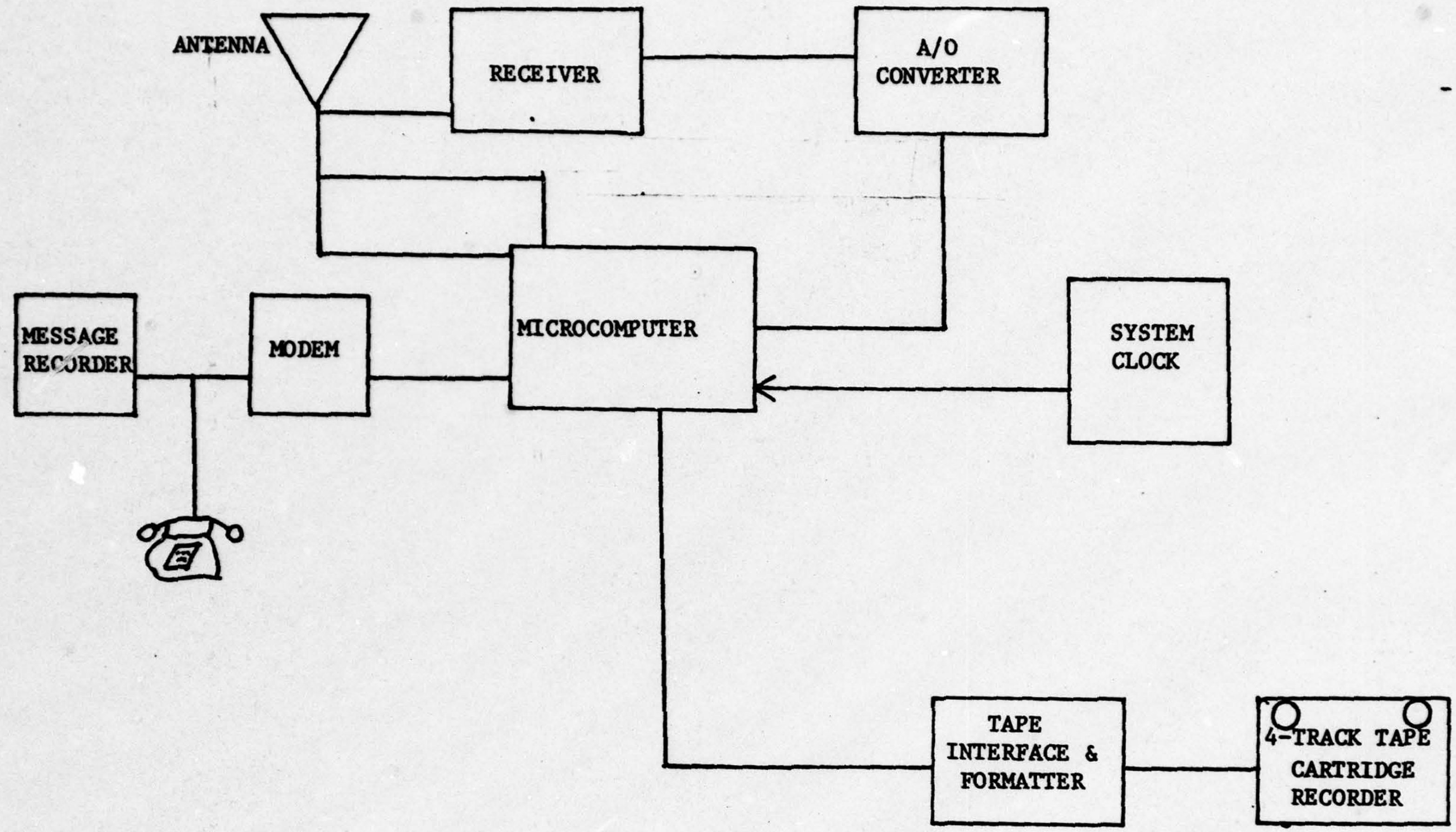

FIGURE 7-1 WHITEHOUSE REMOTE SIGNAL RECORDINC CONFIGURATION

TOUCH TONE SEQUENCE	MEANING
#1	LOAD RECORDING PROGRAM 1
*023900	START RECORDING AT 02:39:00
*025100	STOP RECORDING AT 02:51:00
*1	USE NORTH EAST ARRAY
*60	STEER 60°
**07150	SET RECEIVER FREQUENCY TO 7.150 MHZ
**11	RECORD CW
**500	SET BANDWIDTH TO 500 HZ
***	START OPERATION

FIGURE 7-2 PARAMETER SCENARIO

TOUCH TONE SEQUENCE	MEANING
##	INTERRUPT PROCESSING
*2##	SWITCH TO SOUTH-LOOK ARRAY
**#	RESUME OPERATION

FIGURE 7-3 PROGRAM INTERRUPT SCENARIO

dialog for the interrupt sequence. When the operation has been completed, the system status would revert to idle. When the site personnel came in the next day, the telephone message recorded would be played, and the users tape editing instructions followed. Figure 7-4 shows a possible scheme for converting cartridge tapes to industry-compatible tapes. It should be pointed out that the remote system will only handle one operation at a time. No multiuser/task capability will be included in the system.

With the system that is shown it is possible for the user to modify or create a program from his facility. This situation would require the user to have a telephone modem and some form of data entry such as an ASR 33.

FIGURE 7-4 TAPE EDITING SCHEME

7.1 RECEIVERS

The type of receivers to interface into the system will depend upon the mission. If wideband signals, greater than 20 kHz, are to be monitored, the existing site receivers are digitally tunable. The drawings still exist and appear to provide sufficient information so that they could be interfaced into the microcomputer. It must be pointed out that these receivers were designed and built over 20 years ago, which means they lack the capability of modern digital receivers. In addition to this problem, the interface standards would not be IEEE 488. On the other hand, if the mission calls for narrowband receivers, they will have to be purchased. Many fine digital receivers are commercially available. The price of these receivers will depend upon how sophisticated a receiving system is required.

7.2 TAPE INTERFACE AND RECORDER

The signal recording configuration shows that the data will be stored on a cartridge recorder. This particular method was shown, since recent developments drastically reduced the cost and, at the same time, significantly improve the performance and reliability. Within the last year a cartridge recorder with the following features became available:

- Recording density 1600 bits per inch
- 4-track serial or parallel recording
- 2.88 million byte storage capacity
- 192 thousand bits/second transfer rate
- ANSI/ECMA compatibility
- TTL interface

The tape interface-formatter is microprocessor controlled and permits the program to select the tape unit and control the tape operation. The following tape functions can be controlled by the operating system:

- Track to write data
- Tape direction forward/rewind
- Tape function read/write

7.3 TAPE EDITING AND REFORMATTING

Since the configuration calls for recording the data on cartridge tape, a method must be provided that will convert the tape to an industry-compatible tape. Using the system shown in Figure 7-4 not only is the tape reformatted, but it is also possible to perform certain edit functions. Since the tape reformatting is slow, the operator could enter the appropriate edit instructions, then perform his normal routine.

7.4 ENVIRONMENT

The WHFS is located in New Kent County in Virginia. Within twenty miles of the site is located a paper mill. As a consequence of this paper facility, the air has a high sulphur content. This causes electrical contacts to oxidize more rapidly than normal. Although the site buildings are air-conditioned, the humidity is manually controlled by turning on the heaters when the situation warrants. There are two solutions to the problem. The first would be to purchase equipment that is specially designed to operate in a harsh environment such as Whitehouse. The cost of the rugged versions is at least 30 percent above the standard equipment. The second is to provide a more controlled operating environment. It is recommended that the second option be chosen.

7.5 COST OF THE REMOTE HARDWARE

The cost shown for the system described in this section is only a representative figure, not the actual price. Again, they are included only to give the reader an idea aso the expense involved in putting together the configuration.

Computer-Controlled Receiver (Wideband)	$ NC
Computer-Controlled Receiver (Narrowband)	6,000.00
Computer-Controlled Cartridge Tape Recorder	1,000.00
Computer-Controlled Cartridge Tape Interface and Formatter	2,000.00
Computer-Controlled Cartridge Editing System	3,000.00
Computer-Controlled Industry-Compatible Tape Drive	3,000.00
TOTAL COST	$15,000.00

SECTION 8

MICROPROCESSOR SURVEY

There are many commercially available microprocessors and microprocessor based systems from which to choose. Many of these devices are designed for application in a specific market area, such as, intelligent terminals, narrowband process controllers and other applications which require a low, input data rate or a minimal decision making capability. Other devices are more universal in application and are aimed at the low-end minicomputer market.

The four basic properties of a microprocessor which most affect its usefulness as a processing system building block are:

1) Speed - How fast can the device perform a basic operation?

2) Efficiency - How much processing can be accomplished by each basic operation?

3) Flexibility - How easily may the device be modified to perform a special purpose function?

4) Size - How much physical space is required by the device?

The total cost of the final system will be a function of these four properties.

8.1 MICROPROCESSOR PHYSICAL CHARACTERISTICS

Table 8-1 lists the major physical properties of the set of microprocessors. The eight devices listed form a fairly representative set of currently available microprocessors and all are either second-sourced or made by a major semi-conductor manufacturer. The list includes three eight-bit machines and five sixteen-bit machines, of which, four are implemented using a bit-slice central processing unit.

Entries in the table may be used to estimate power, clock and physical space requirements for a basic microprocessor module. Notice that the bit-slice processors require two-to-three times the space and more than four times the power required by the single chip CPU's. This is due to the space and power required by the bit-slices for microinstruction decoding logic and micromemories.

Table 8-2 supplies additional information concerning the architecture of the device, as seen by the programmer, along with memory addressing modes and the execution times for some instructions which are common in signal processing applications. Some explanation is required in order to correctly interpret the execution times found in Table 8-2. The memory-to-register addition time is the time required to add any memory location to an accumulator register and the memory-to-memory move time is the time required to move the contents of any memory location to any other memory location. If an address index register is required to perform this operation, the time required to load that index register is included in the table value. If the eight-and sixteen-bit processors are to be compared on the basis of sixteen-bit

TABLE 8-1

DEVICE PHYSICAL CHARACTERISTICS

DEVICE	MFG.	TECH.	PACKAGE	CPU SIZE BITS	CLOCK and t_C μs	SUPPLY VOLTAGE POWER	Est. Size for Min. Sys. - in.^{2}
8080	INTEL TI	NMOS	40 PIN DIP	8	TWO PHASE $0 \leq V_{CLK} \leq V_{DD}$ $0.32 < t_C < 2.0$ $0.48 < t_C < 2.0$ TI	$V_{DD} = 12V$ @ 67 ma $V_{CC} = 5V$ @ 75 ma $V_{BB} = -5V$ @ -1 ma	10
6800	MOTOROLA AMI	NMOS	40 PIN DIP	8	TWO PHASE $0 < V_{CLK} < V_{CC}$ $1.00 < t_C < 10.0$	$V_{CC} = 5V$	10
2650	SIGNETIC	NMOS	40 PIN DIP	8	ONE PHASE $0 < V_{CLK} < V_{CC}$ $0.80 < t_C < \infty$	$V_{CC} = 5V$ @ 100 ma	10
IMP-16	NATIONAL	PMOS	40 PIN DIP PER 4 BIT RALU	16	FOUR PHASE $V_{GG} < V_{CLK} < V_{SS}$ $1.43 < t_C < 10.0$	$V_{SS} = 5V$ $V_{GG} = -12V$ $P_D = 750$ mW	30
9900	TI	NMOS	64 PIN DIP	16	FOUR PHASE $0 < V_{CLK} < V_{DD}$ $t_C \sim 0.33$	$V_{DD} = 12V$ @ 30 ma $V_{CC} = 5V$ @ 125 ma $V_{BB} = -5V$ @ -1 ma	.15
2900	AMD MOTOROLA RAYTHEON	SCHOTTKY BIPOLAR	40 PIN DIP PER 4 BIT SLICE	16	SINGLE PHASE TTL $t_C \sim 0.2$	$V_{CC} = 5V$ @ 185 ma PER SLICE	30
3000	INTEL SIGNETIC	SCHOTTKY BIPOLAR	40 PIN DIP PER 2 BIT SLICE	16	SINGLE PHASE TTL $t_C \sim 0.2$	$V_{CC} = 5V$ @ 135 ma PER SLICE	35
SBP0400	TI	I^2L	40 PIN DIP PER 4 BIT SLICE	16	SINGLE PHASE TTL $t_C \sim 1.0$	$V_{CC} = 5V$ @ 150 ma PER SLICE	30

TABLE 8-2

TYPICAL INSTRUCTION EXECUTION TIMES, PROGRAMMABILITY AND SUPPORT

DEVICE	MEM - REG ADD TIME	MEM - MEM MOVE TIME	CND. BR TIME	PGRMAPLE REGS.	ADDRESSING MODES	MICRO PGRMABLE	SOFTWARE
8080	7.36 μs	14.72 μs	3.2 μs	16-bit PC 16-bit STACK 4 8-bit reg. pairs 8-bit ACC.	DIRECT REGISTER REGISTER - INDIRECT IMMEDIATE	NO	YES
6800	4.0 μs	9.0 μs	4.0 μs	16-bit PC 16-bit STACK 16-bit INDEX 2 8-bit ACC.	DIRECT RELATIVE REGISTER IMMEDIATE EXTENDED INDEXED	NO	YES
2650	9.6 μs	19.2 μs	7.2 μs	15-bit PC 8x15 SUB. ADDR. STK 7 8-bit regs.	REGISTER INDIRECT IMMEDIATE AUTO-INC RELATIVE AUTO-DEC ABSOLUTE INDEXED	NO	YES
IMP-16				16-bit PC 16x16 WRD LIFO STK 6 16-bit GEN REGS 16-bit STATUS		YES	YES
9900	7.33 μs	10.0 μs	3.33 μs	16-bit PC 16-bit STATUS 16-bit WP 16-WRD MEM REG FILE	REGISTER RELATIVE REGISTER-INDIRECT DIRECT INDEXED AUTO-INC IMMEDIATE	NO	YES
2900	2.0 μs	2.0 μs	1.75 μs	16-bit PC 16-bit STACK 8-bit STATUS 6 16-bit GEN REGS	SAME AS PDP-11 FAMILY	YES	NO
3000	2.0 μs	2.0 μs	1.75 μs	16-bit PC 16-bit STACK 8-bit STATUS 6 16-bit GEN REGS	SAME AS PDP-11 FAMILY	YES	NO
SBP0400	8.0 μs	8.0 μs	7.0 μs	16-bit PC 16-bit STACK 8-bit STATUS 6 16-bit GEN REGS	SAME AS PDP-11 FAMILY	YES (PLA)	NO

data words, then the execution times in the table for the eight-bit processors should be doubled. Keeping these facts in mind, it becomes apparent that a bipolar bit-slice CPU such as the AMD 2900 or the Intel 3000, is between five and ten times faster than the eight-bit CPU's.

8.2 RCA 1802 MICROPROCESSOR

The prime power to WHFS is very unreliable from the standpoint of interruptions to service. In addition, Whitehouse suffers from severe summer lightning exposure. The automated site operations should be isolated from these power disruptions. The RCA 1802 microprocessor is mentioned because it appears to be suited to the Whitehouse power environment. It consumes about 1000 times less power than most microprocessors and is built to operate for years on batteries. The system could be designed so that this processor takes over during large power outages.

In addition to the microprocessor, provision would have to be made to switch the peripheral devices to the auxiliary power source.

SECTION 9

WHITEHOUSE PROMOTION

The WHFS name no longer is appearing in HF circles. The reports generated by ITT-EPL besides giving technical information also served as a form of promotion. This promoting is no longer available. As the name of the site fails to appear, old users will forget about its capabilities and, of course, potential users will not know of its existence. An effort should be directed toward developing a new brochure detailing the upgraded capabilities of the WHFS, and emphasizing the low cost and accessibility. In addition to the brochure, a consultant should be retained or an individual within ONR should be assigned the responsibility of visiting potential users informing them of the site and how it can benefit their operation. This type of selling is going to be necessary if Whitehouse is going to survive.

SECTION 10

ROLE OF SITE PERSONNEL

If the site were to be provided with the degree of automation and the automata suggested here, the roles of the site personnel would include: a) housekeeping and electronic maintenance; b) programming and debugging; c) overview of the results achieved during all operations conducted; d) exercise of judgment and insertion of interrupts and reprograms to conform to the actual real-world conditions encountered during operations; e) instruction of customers in the efficient use of the site when planning operations; f) supervisory control of radiation at the site.

10.1 LEGAL REQUIREMENTS

It is not suggested that totally unmanned transmission operations be undertaken. For experimental radars of the type employed at the site, FCC or IRAC approvals would never be given for unmanned radiation operations; i.e., there would always be required an operator (actually two) on duty when transmissions are being made. However, the operators duties would be reduced to executive overview and safety backup to prevent harmful interference from occurring because of either control, transmission, or alarm equipment failure at the site.

There always are required a human interface with national monitoring services, since they might call in at any time to request modification or cessation of transmissions.

Thus, the personnel roles would change from the past ones of manual operators to executive managers of the preprogrammed scenarios being exercised by the automatic controllers.

SECTION 11

RECOMMENDATIONS

This report makes several recommendations which are summarized below:

- No additional funds be expended on the present SEL-85 computer.
- Remote site operations be microprocessor controlled.
- Room containing the remote operations equipment be temperature/humidity controlled.
- Equipment be IEEE 488 Bus compatible.

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This report details the unique assets of the Whitehouse field site and describes the current hardware configuration. An alternate approach using telephone communications between potential users and the Whitehouse field site is described. The use of microprocessors to control the remote operations is described with supporting budgetary estimates.

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